Inventory Preparation for Emissions Modeling

Emission Inventory Conference

Training Session

April 30, 2001

Presenter Background

- Gregory Stella, U.S. EPA
  - Environmental Engineer
  - Emission Factor and Inventory Group
  - Primary Roles
    - Preparation of Inventories for Emissions Modeling
    - Emissions Modeling Support for Regulatory Actions
    - International Emissions Inventory Coordination
    - Emission Projection and Projection Tools

Acknowledgements

- Marty Wolf & Paula Fields
  - Eastern Research Group (ERG)

- Graphics Provided From
  - “Mexico Emissions Inventory Program Manuals; Volume VIII - Modeling Inventory Development”
  - http://www.epa.gov/ttn/catc/dir1/modeldev.pdf

What is Emissions Modeling?

- The Translation of a Mass Inventory Into an Inventory Ready for Input Into an Air Quality Model
- Mass Inventory Which Can Support Temporal, Spatial, Speciation, and Projection Needs

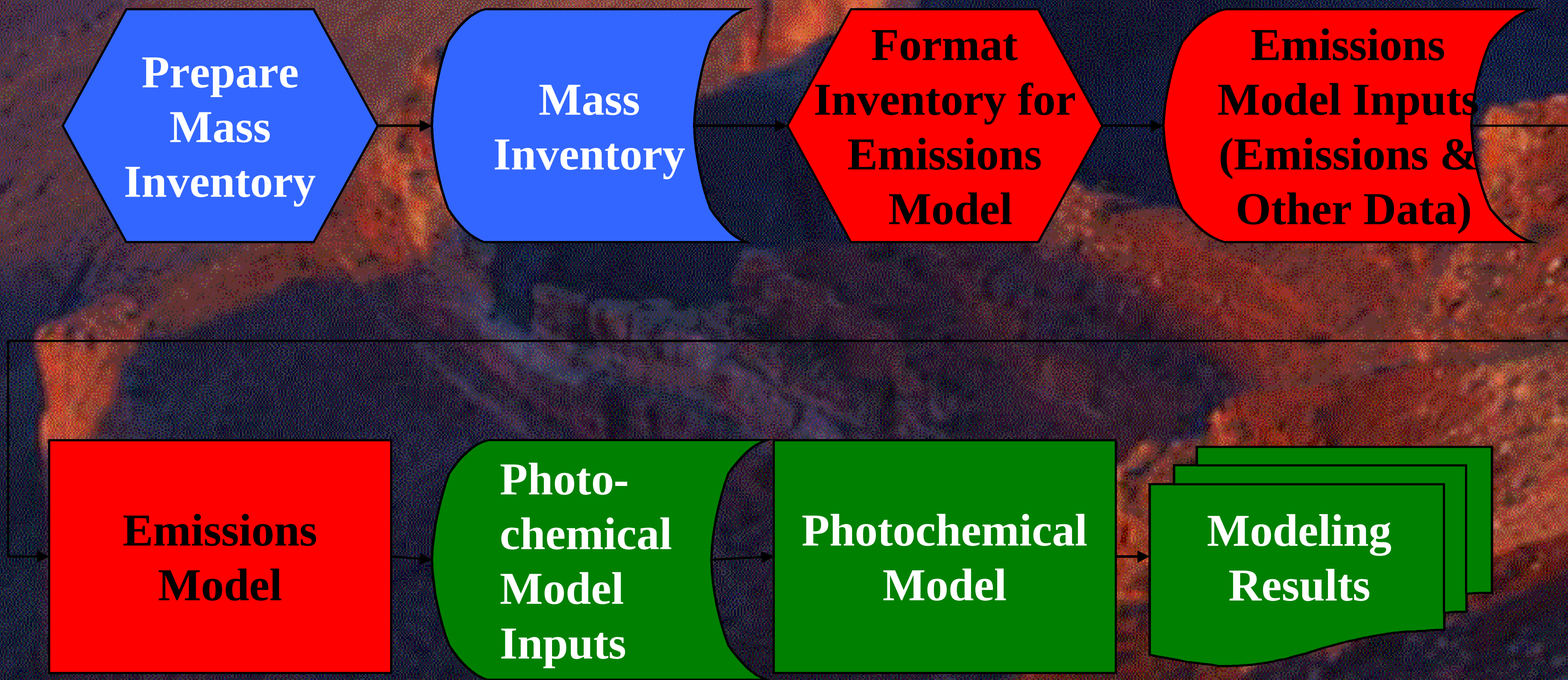
What is Emissions Modeling? (2)

- Providing Detailed Emission Inventory Plan
  - Location
  - Release Times / Frequency
  - Process Types
- Combining with Meteorological Data
- Modeling Complex Chemical Interactions and Transport Activity

What is Emissions Modeling? (3)

- Outputs For Multiple Uses
  - Attainment Demonstrations
  - Source Contribution Study
  - Control Program Effectiveness
  - Visibility and Haze Improvement
  - Transport Analyses
  - Risk Assessment Studies

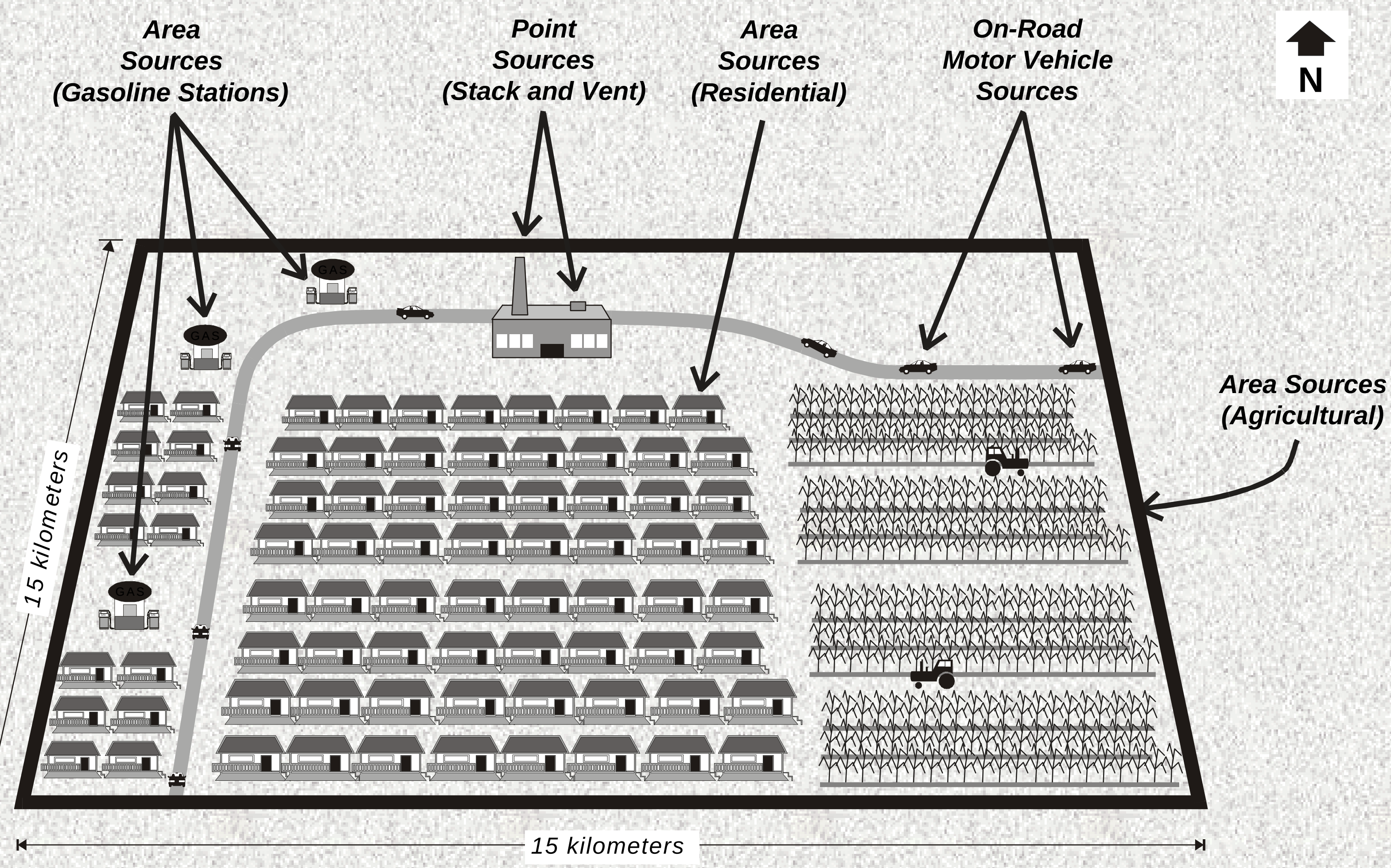
The Big Picture



Output of Emissions Models

- Gridded Emissions
  - Surface Layer/Elevated
- Speciated Emissions
- Temporally Allocated Emissions
- Projected and Controlled Emissions
- Generally Contains No Specific Information
  - Plant IDs, SCC, Etc.

Example Modeling Domain



Example Domain Emissions

	Annual Emissions (Tons/yr)		
Emission Source	**VOC**	**NOx**	**CO**
Point Sources			
Factory (Boiler)	200	400	600
Factory (Surface Coating)	300	0	0
Mobile Sources			
Automobiles	400	800	600
Area Sources			
Gasoline Stations	150	0	0
Residential Commercial Solvent Use	200	0	0
Agricultural Pesticide Application	100	0	0

Development of Emissions Inventories for Modeling

- Modeling Inventory Requirements
- Quality Assurance/Quality Control
- Emission Estimation
- Temporal Allocation
- Spatial Allocation
- Pollutant Speciation
- Emission Projections

Today’s Presentation

- Pollutant and Model Neutral
- Emissions Modeling Background
- Description / Examples / Problems

"Junk In Equals Junk Out"

- Results Are Only as Good as Inputs
- Recommended that Additional AND Redundant QA/QC Performed on Inventory
- Emissions Modeling Specific QA
  - Including Running Emission Model

Modeling Inventories Are ...

- More Than Just Emissions
- Actual Source Specific Data
  - Locations
  - Operating Data
  - Process Specifications
- Cross-Reference Information
  - Necessary to Link to Ancillary Files

Air Quality Models Want ...

- Hourly Time Resolution
- Gridded Emissions (Vertical & Horizontal)
- Chemical Species To Match AQ Chemistry
- All Source Type Emissions
  - Anthropogenic, Biogenic, Geogenic
- Domain Wide Coverage
- Process & Control Information

Why Such Detail?

- Source Distance Relative to Receptors
- Many Sources Have Significant Temporal Variation in Emission Rates
- Different Processes Have Varying Reactivities and Volatilities
- Release Heights Have Transport and Diffusion Characteristics
- Data Used as Surrogates or Cross-Reference

Point Source Inventory Elements

- Required for Modeling
  - Process Level Emissions
  - Geographic Coordinates
  - Stack Parameters
  - Operating Schedule
- Additional Projection Needs
  - SIC
  - Activity
  - Emission Factors (Control Efficiency)

Area Source Inventory Elements

- Required for Modeling
  - Process Level Emissions
  - Operating Schedule
- Additional Projection Needs
  - Activity
  - Emission Factors (Control Efficiency)

Quality Assurance / Control

- Emissions Information
- Missing Data
- Stack Parameters
- Geographic Coordinates

Emission Levels

- Compare Sources and Source Types to Previous Years
  - Are Same Facilities in Operation?
  - Are Same Source Types Represented?
- Compare Emissions to Sources of Same Type
  - Are Emissions Comparable?
  - Are All Source Types Represented?

Emission Checks

- Top Ten Facility List
- Emissions vs. Stack Information
  - Small Stack, Large Emissions; Vice-Versa
  - Emission Output Concentration
- Emissions vs. Source Type
  - Consistent Reporting
  - Units

Missing Data

- Facility/Type Identification
- Pollutant Coverage
- Source Category Codes
- Locational Information
- Source Type
- Parameters Also Needed to Associate Ancillary Files

Stack Parameters

- Height
- Diameter
- Flow
- Temperature
- Exit Velocity
- Dimensional Analysis / Units
  - Add Exit Velocity Equation Here

Geography

- Correct FIPS County Codes
- Valid Lat/Lon Data
- Emissions or VMT on Roadway Link
- Categories Represented in Appropriate Area
  - Regional Emission Activities

Emission Estimation

- Used for Episode Specific Emissions Based on Episode Specific Conditions
  - Meteorological Information
  - Seasonal Activity
- "On-The-Fly" Estimates
  - On-highway Mobile
  - Biogenics

Temporal Allocation

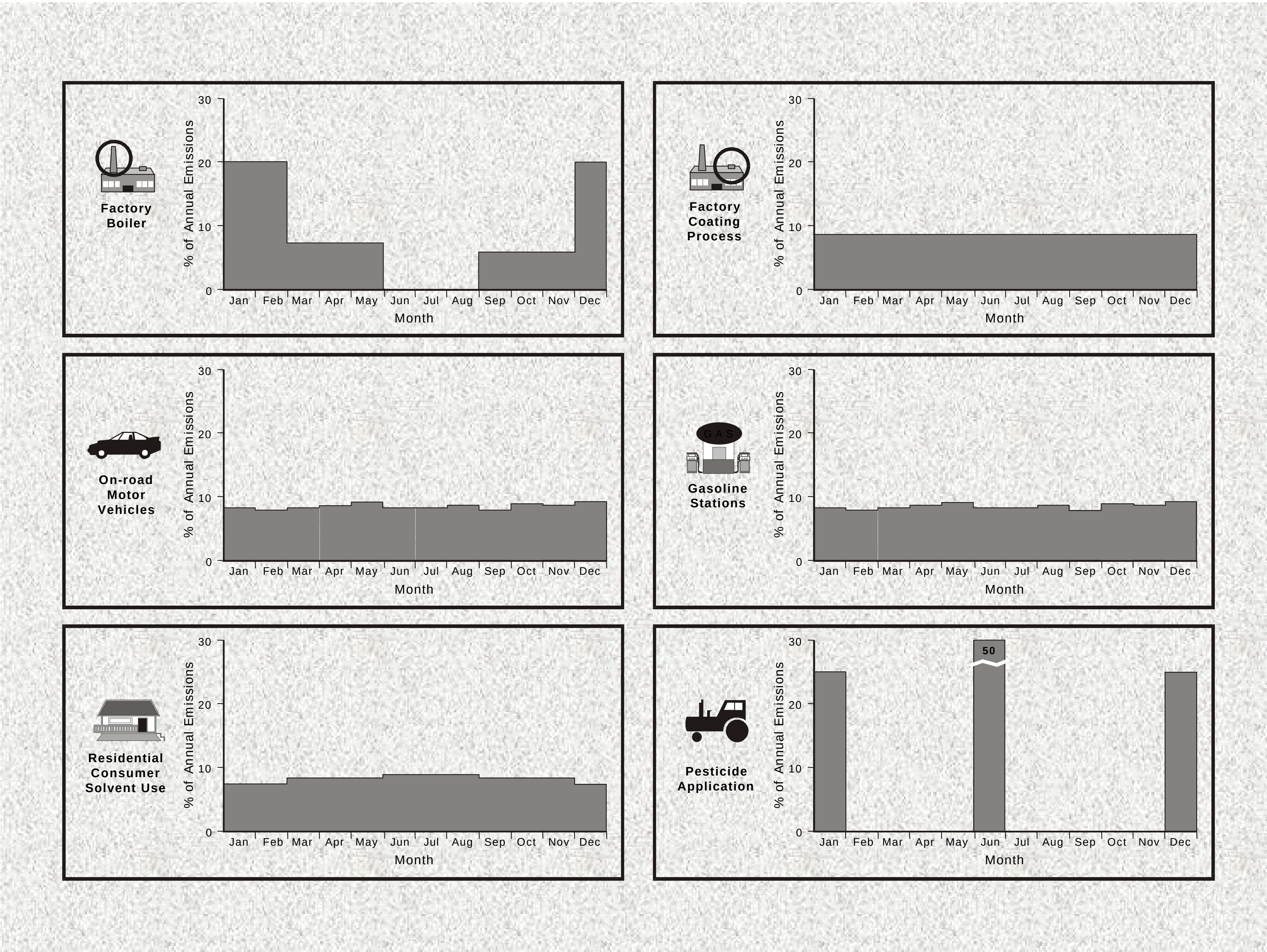
- Allocation of Emissions to Time-Period Required by Model
  - Annual or Daily Emissions to Hourly Emissions
- Use Operating Schedule Data and Default Temporal Profiles
  - Actual Hours, Days, Weeks, Seasonal Data

Temporal Allocation (2)

- Monthly or Seasonal Allocation
  - April, Summer, Ozone Season, etc.
- Weekly Allocation
  - Average Day, Wednesday, Sunday, etc.
- Hourly Allocation
  - 8 AM, Noon, 6 PM, etc.
- Holiday Allocation
  - 4th of July, Labor Day, Christmas, etc.

Monthly Allocation Profiles

- Used to Generate Seasonal or Monthly Emission and Activity Estimates
- Combinations of Months Used for Seasons
  - Spring (Mar, Apr, May)
  - Summer (Jun, Jul, Aug)
  - Fall (Sep, Oct, Nov)
  - Winter (Dec, Jan, Feb)



Factory Boiler
Factory Coating Process
On-road Motor Vehicles
Gasoline Stations
GAS
Residential Consumer Solvent Use
Pesticide Application
50
% of Annual Emissions
0
10
20
30
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

Seasonal Temporal Allocation

- Example:
  - Calculate Spring NOx Emissions from Factory Boiler in Example Domain
- Steps:
  - Estimate Seasonal Allocation Factor from Monthly Profiles
  - Apply Seasonal Allocation Factor to Annual Emissions

Seasonal Temporal Allocation

- Calculate Spring Allocation Factor

$$AF_{Spr} = AF_{Mar} + AF_{Apr} + AF_{may}$$

AF_{Spr} = Spring Temporal Allocation Factor

AF_{Mar} = March Temporal Allocation Factor

AF_{Apr} = April Temporal Allocation Factor

AF_{May} = May Temporal Allocation Factor

Seasonal Temporal Allocation (2)

- From Seasonal Allocation Profiles

  $AF_{Spr} = 0.073 + 0.073 + 0.073$

  $AF_{Spr} = 0.219$

- Apply Spring Factor to Annual Emissions

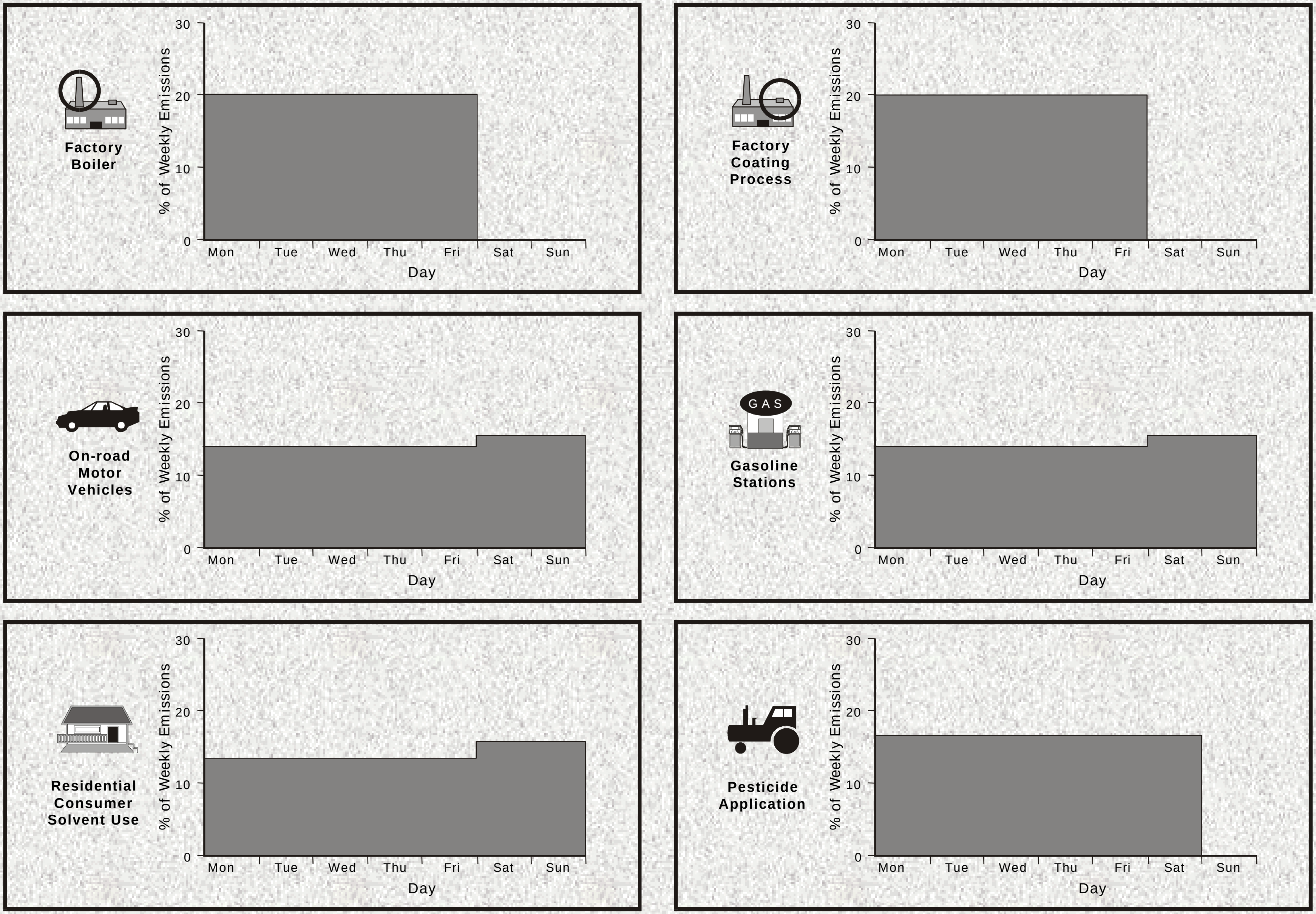
  $E_{Spr} = E_{Ann} * AF_{Spr}$

  E_{Spr} = 400 Tons NOx/yr * 0.219

  E_{Spr} = 87.6 Tons NOx

Weekly Allocation Profiles

- Used to Generate Specific Day or Day Type Emission and Activity Estimates
- Most Sources Are Not Constant Emitters
  - Weekday vs. Weekend Differences
  - Specific Day of Week
    - Mon, Tues, Wed, etc.
  - Recreational Activities
    - More on Weekends


Factory Boiler
Factory Coating Process
On-road Motor Vehicles
Gasoline Stations
GAS
Residential Consumer Solvent Use
Pesticide Application
% of Weekly Emissions
Day
Mon
Tue
Wed
Thu
Fri
Sat
Sun
0
10
20
30

Weekly Temporal Allocation

- Example:
  - Calculate Average Thursday NOx Emissions from Factory Boiler in Example Domain
- Steps:
  - Estimate Average Thursday Allocation Factor from Weekly Profiles
  - Apply Average Thursday Allocation Factor to Seasonal Emissions

Weekly Temporal Definitions

- Average Daily Factor (AF_{ADay})
  - Contribution of Any One Day to Season
  - 1.00 / 91 days per season
- Average Daily Activity (AC_{Day})
  - Percentage of Ave Day Activity for Week
  - 1.00 / 7 days per week
- Specific Day Activity ($AC_{SpecDay}$)
  - Percentage of Specific Day Activity for Week

Weekly Temporal Allocation

- Calculate Average Thursday Allocation Factor

$$AF_{Thur} = AF_{ADay} * (AC_{Thur} / AC_{Day})$$

AF_{Thur} = Thursday Allocation Factor

AF_{ADay} = Average Daily Factor

AC_{Thur} = Thursday Activity Factor

AC_{Day} = Average Daily Activity Factor

Weekly Temporal Allocation (2)

- From Weekly Allocation Profiles

  AF_{Thur} = (1/91) * (0.200/0.1429)

  = 0.0154

- Apply Thursday Factor to Season Emissions

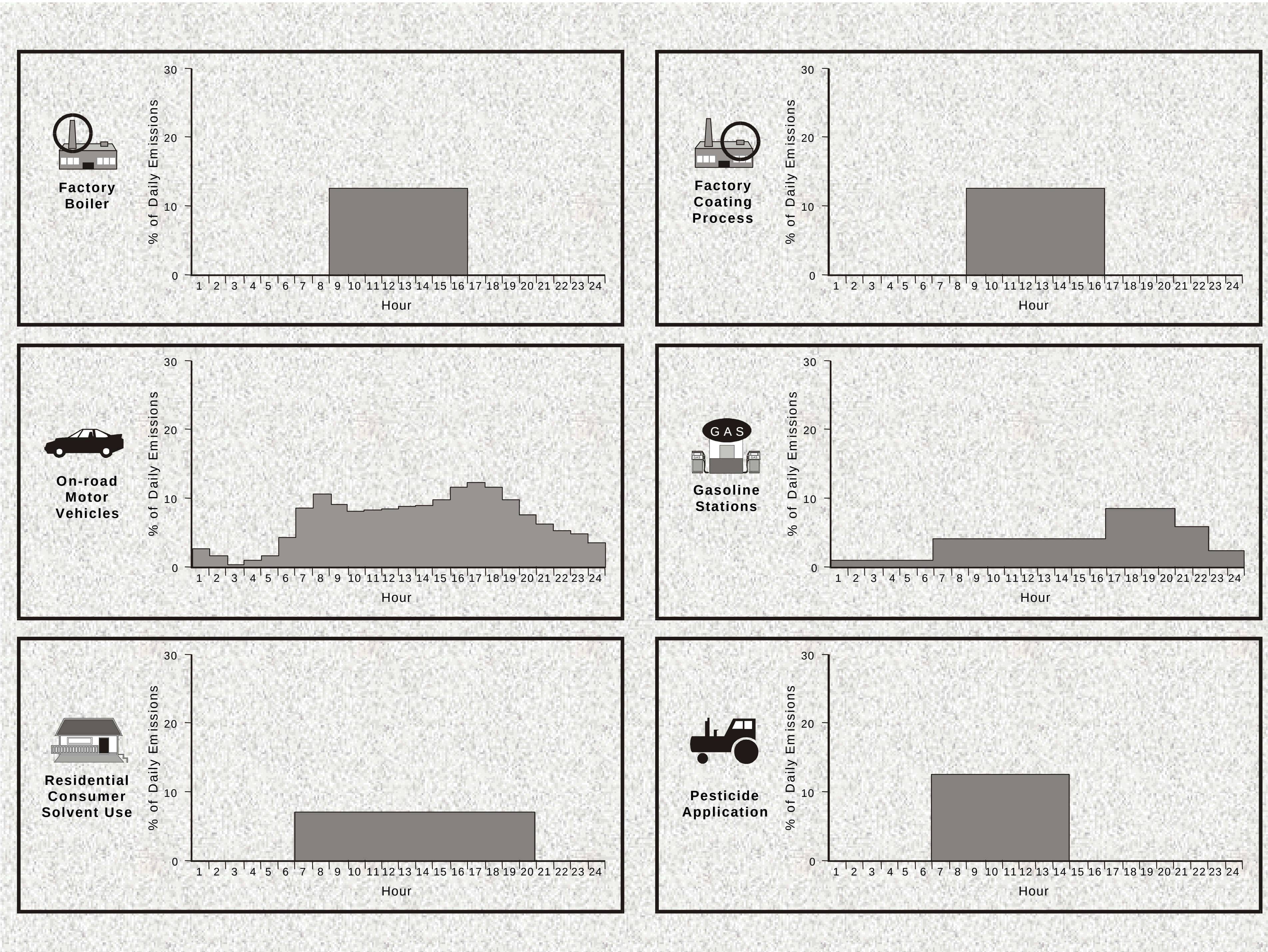
  $E_{Thur} = E_{Spr} * AF_{Thur}$

  E_{Thur} = 87.6 Tons NOx/Spring * 0.0154

  E_{Thur} = 1.35 Tons NOx/ Spring Thursday

Hourly Allocation Profiles

- Used to Generate Specific Hour Emission and Activity Estimates
- Most Sources Are Not Constant Emitters
  - Shift Work
  - Rush Hour
  - Day/Night Activities


Factory
Boiler
% of Daily Emissions
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Factory
Coating
Process
% of Daily Emissions
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
On-road
Motor
Vehicles
% of Daily Emissions
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
GAS
Gasoline
Stations
% of Daily Emissions
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Residential
Consumer
Solvent Use
% of Daily Emissions
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
Pesticide
Application
% of Daily Emissions
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour

Hourly Temporal Allocation

- Example:
  - Calculate 2:00 P.M. NOx Emissions from Factory Boiler in Example Domain
- Steps:
  - Estimate 2:00 P.M. Allocation Factor from Hourly Profiles
  - Apply Hourly Allocation Factor to Daily Emissions

Hourly Temporal Allocation

- Calculate Hourly Allocation Factor

$$AF_{Hour} = AC_{Hour} / AC_{Day}$$

AF_{Hour} = Hourly Allocation Factor

AC_{Hour} = Hour Specific Activity

AC_{Day} = Daily Activity

Hourly Temporal Allocation (2)

- From Hourly Allocation Profiles

  AF_{2PM} = 0.125/1.00

  = 0.125

- Apply Hourly Factor to Daily Emissions

  $E_{2PM} = E_{Thur} * AF_{2PM}$

  E_{2PM} = 1.35 Tons NOx/Thursday * 0.125

  E_{2PM} = 0.1688 Tons NOx/ 2PM Spring Thursday

Temporal Allocation Issues

- Majority of Submitted Data Fall into Uniform Daily and Hourly Profiles
  - 24 hours/day, 7 days/week
- Can Use Hourly Emissions If Available
  - CEM, Other Monitored Sources
- PM/Visibility Modeling Will Require Emissions for Winter, Spring, Summer, and Fall Seasons

Temporal Allocation Issues (2)

- Facility vs. Process Differences
  - Each Unit At Plants Can Have Different Profile
- Area Sources Generally Use Default Profile
  - Ensure Appropriate Temporal Factors Used in Your Local Area
- Mobile Sources
  - Large Differences in Hour / Day / Week / Season Activity

Temporal Allocation Issues (3)

- Holiday Activity
  - Different Than Weekday or Weekend Mix
  - Less Industry Activity
  - Fewer Shifts
  - Alternate Hours
  - More Travel Activity
  - More Recreational Activity

Temporal Allocation Exercise

- Calculate The VOC Emissions From Residential Consumer Solvent Use For The 9:00 A.M. Hour On A Saturday In Winter

Temporal Allocation Exercise (2)

- From Seasonal Allocation Profiles

  $AF_{Win} = 0.075 + 0.075 + 0.075$

  $AF_{Win} = 0.225$

- Apply Winter Factor to Annual Emissions

  $E_{Win} = E_{Ann} * AF_{Win}$

  $E_{Win} = 200 \text{ Tons VOC/yr} * 0.225$

  $E_{Win} = 45.0 \text{ Tons VOC}$

Temporal Allocation Exercise (3)

- From Weekly Allocation Profiles

$$AF_{Sat} = (1/91) * (0.162/0.1429)$$
$$= 0.0125$$

- Apply Saturday Factor to Season Emissions

$E_{Sat} = E_{Win} * AF_{Sat}$

E_{Sat} = 45.0 Tons VOC/Winter * 0.0125

E_{Sat} = 0.563 Tons VOC/ Winter Saturday

Temporal Allocation Exercise (4)

- From Hourly Allocation Profiles

  $AF_{9AM} = 0.071/1.00$

  $= 0.071$

- Apply Hourly Factor to Daily Emissions

  $E_{9AM} = E_{Sat,Win} * AF_{9AM}$

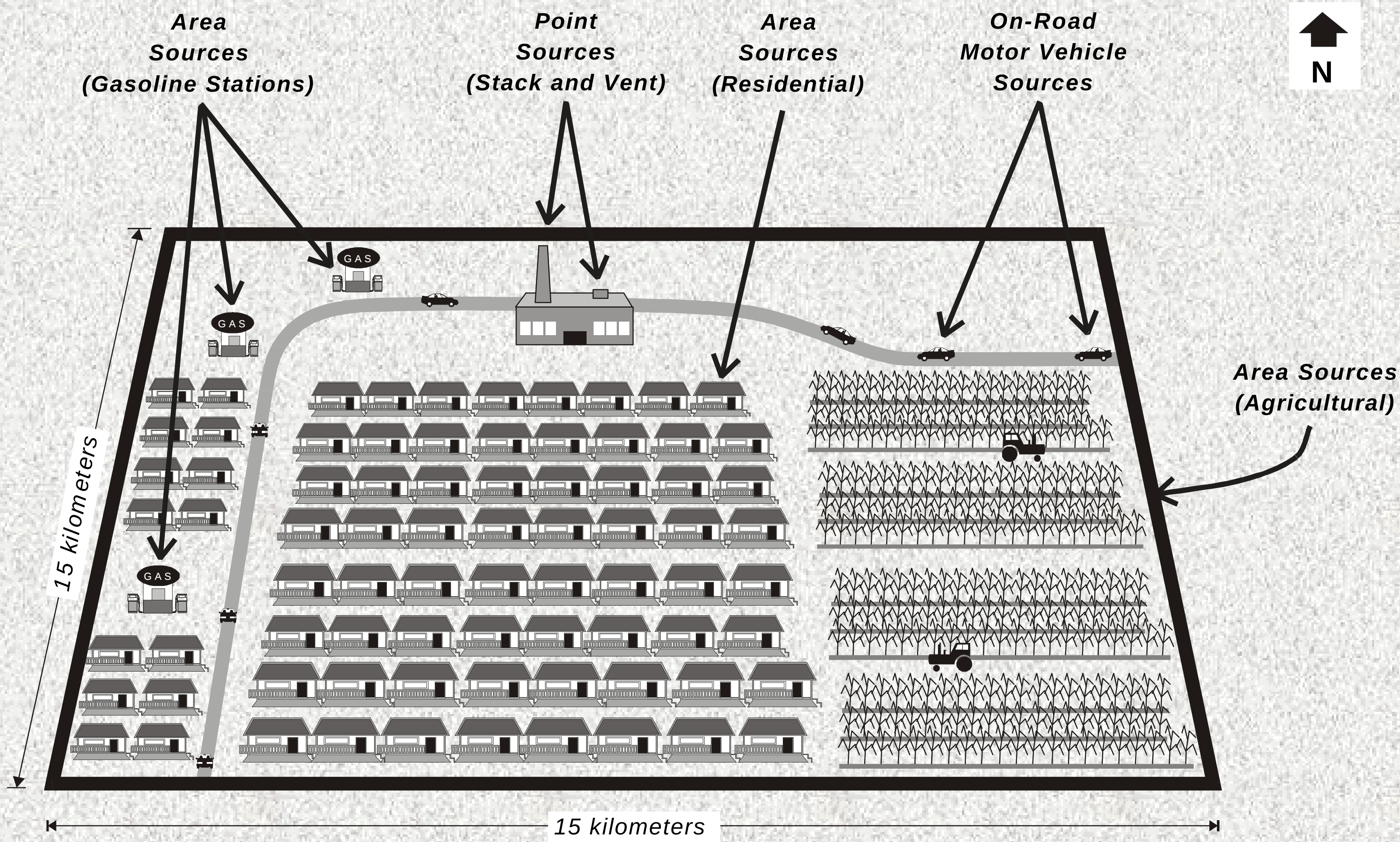
  E_{9AM} = 0.563 Tons VOC * 0.071

  E_{9AM} = 0.040 Tons VOC/ 9AM Winter Saturday

Spatial Allocation

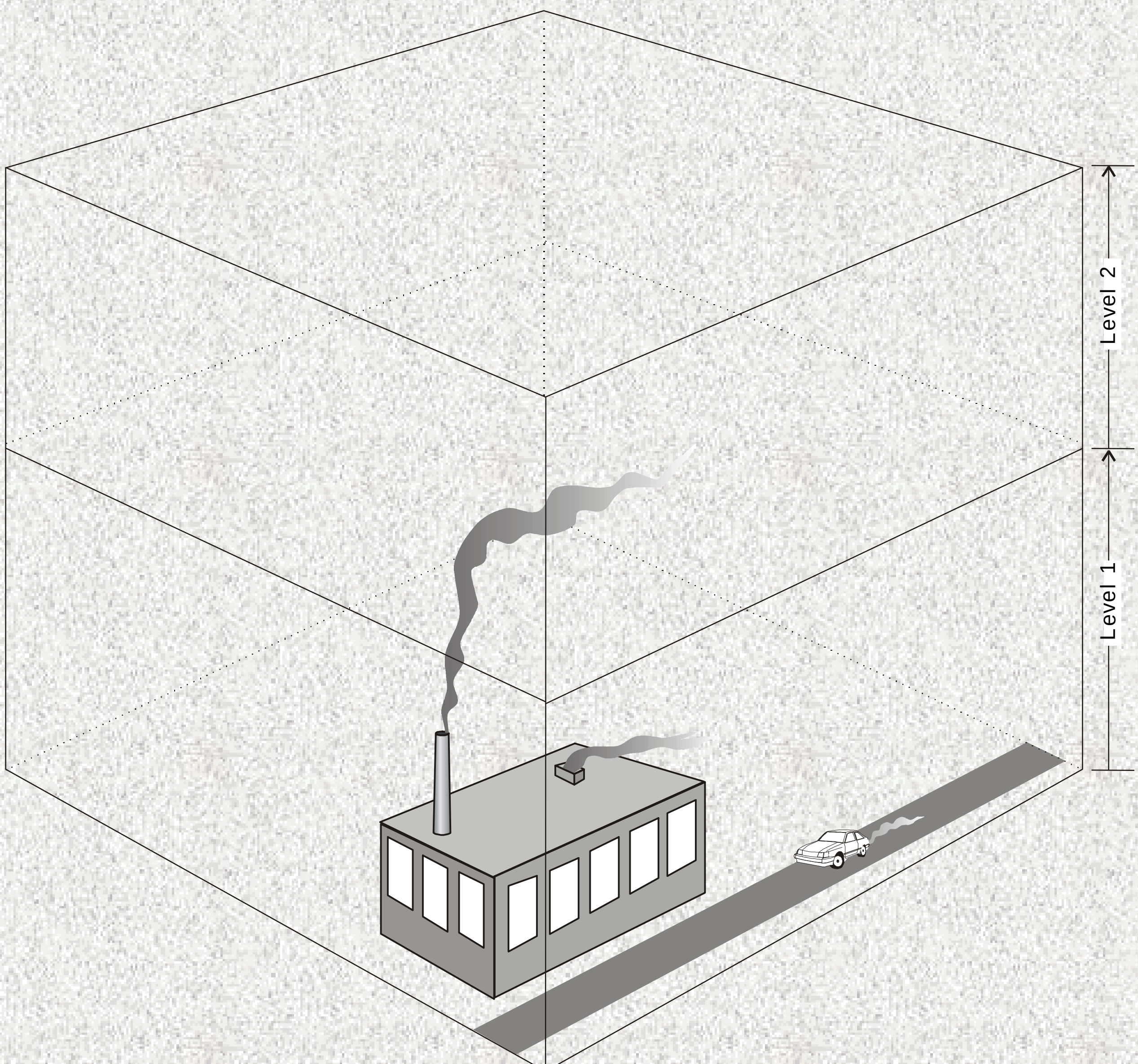
- Physical Location of Emission Sources
  - Emission Inventories Usually Provide Data At County or Census Tract Levels
  - Emission Models Use Allocation Ratios to Further Define Source Location
  - Modeling Objective Will Define Level
    - Local Scale Risk Exposure, Regional / National / International Transport Analyses

Example Modeling Domain



Spatial Allocation (2)

- Allocate Emissions in 3-D
  - Point Sources Use Geographic Coordinates and Stack Parameters
  - Area & Nonroad Sources Use Gridded Spatial Surrogates
  - Link-Based Sources Use Linear Network or Gridded Spatial Surrogates


Level 2
Level 1

Spatial Allocation (3)

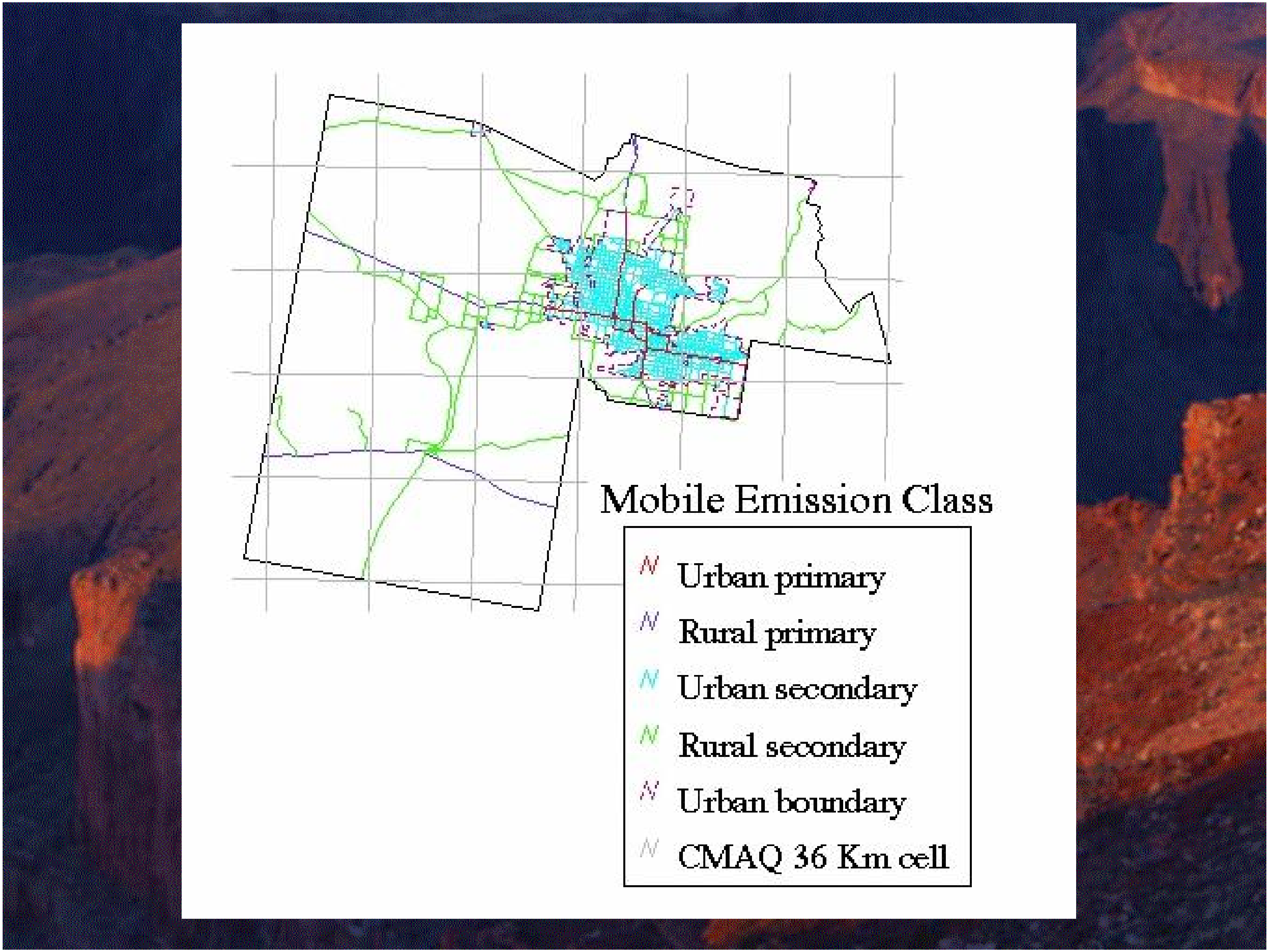
- Point Sources
  - Latitude / Longitude Data
    - Horizontal Resolution
    - Stack / Unit / Facility Specific
  - Stack Parameters
    - Vertical Resolution
    - Plume Rise / Layer Distribution

Spatial Allocation (4)

- Area and Nonroad Sources
  - Allocated Based On Related Activity (SCC)
    - Population (Dry Cleaners)
    - Water (Recreational Motorboats)
    - Housing (Residential Combustion)
    - Agricultural Land (Animal Husbandry)

Spatial Allocation (5)

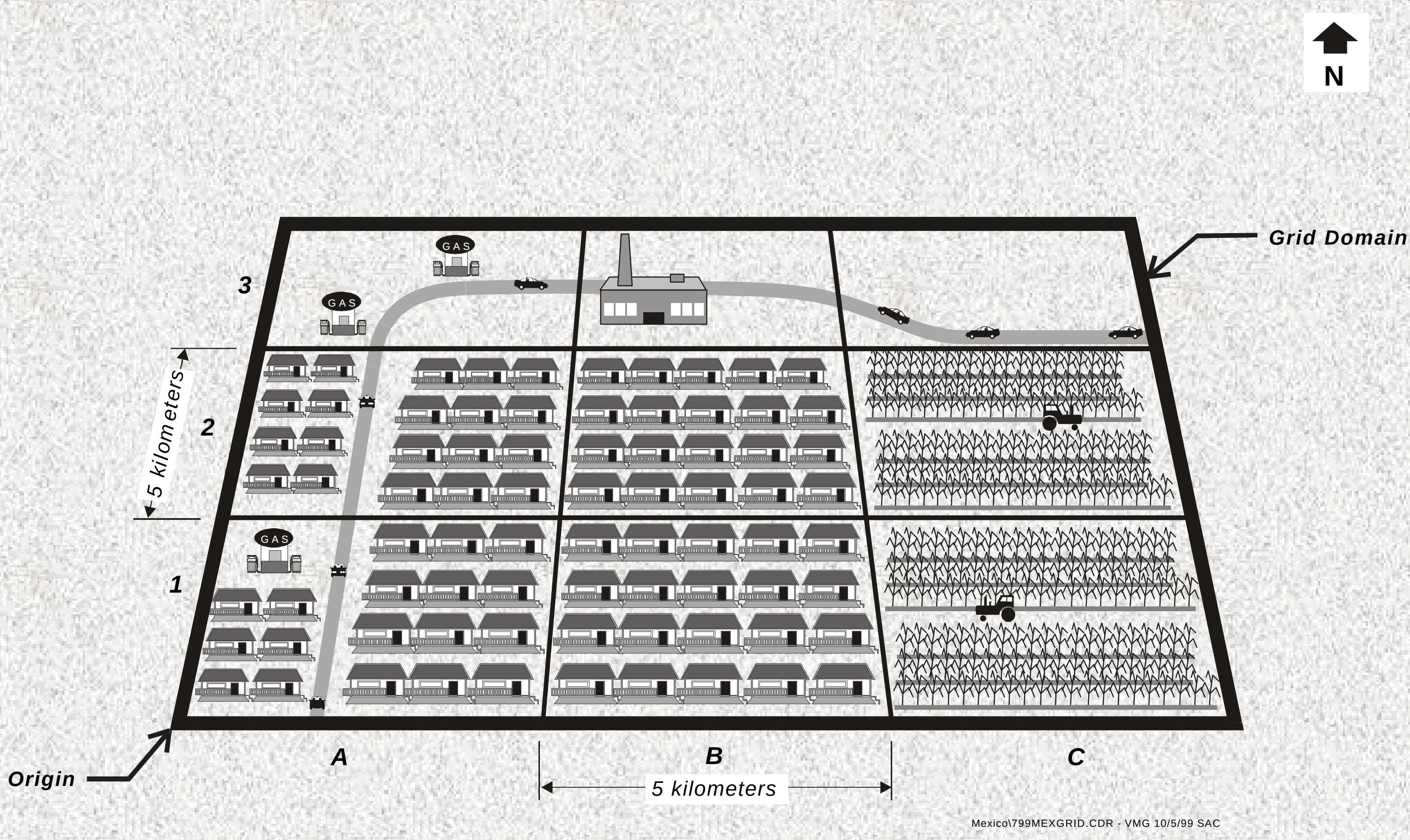
- Link-Based Sources
  - Linear Transportation Networks
    - Highways
    - Railroads
    - Commercial Marine Vessels
  - Emissions or Activity Split Along Links Based on Allocation Data


Mobile Emission Class
Urban primary
Rural primary
Urban secondary
Rural secondary
Urban boundary
CMAQ 36 Km cell

Spatial Allocation Ratios

- Graphical Interface Systems (GIS) Used To Determine Gridding Ratio Information
  - Apply Surrogates To Site Emissions
  - Ratio of Grid Cell or Census Tract Contribution to Geographic Domain Emissions
  - Can Have Multiple Areas Within a Grid Cell
  - Usually Calculated Outside of Emissions Model

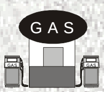
Example Gridded Domain



Example Spatial Ratios

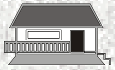
Highway Vehicles

	A	B	C
3	0.200	0.200	0.200
2	0.200	0	0
1	0.200	0	0



Gasoline Stations

	A	B	C
3	0.667	0	0
2	0	0	0
1	0.333	0	0



Residential Consumer Solvent Use

	A	B	C
3	0	0	0
2	0.250	0.250	0
1	0.250	0.250	0

Agricultural Pesticide Use

	A	B	C
3	0	0	0
2	0	0	0.500
1	0	0	0.500

Spatial Allocation Example

- Example:
  - Calculate Annual VOC Emissions from Gasoline Stations in Grid Cell (A,1)
- Steps:
  - Estimate Grid Cell Allocation Factor from Gridding Profiles
  - Apply Grid Cell Allocation Factor to Annual Emissions

Spatial Allocation Example (2)

- Estimate Grid Cell Allocation Factor

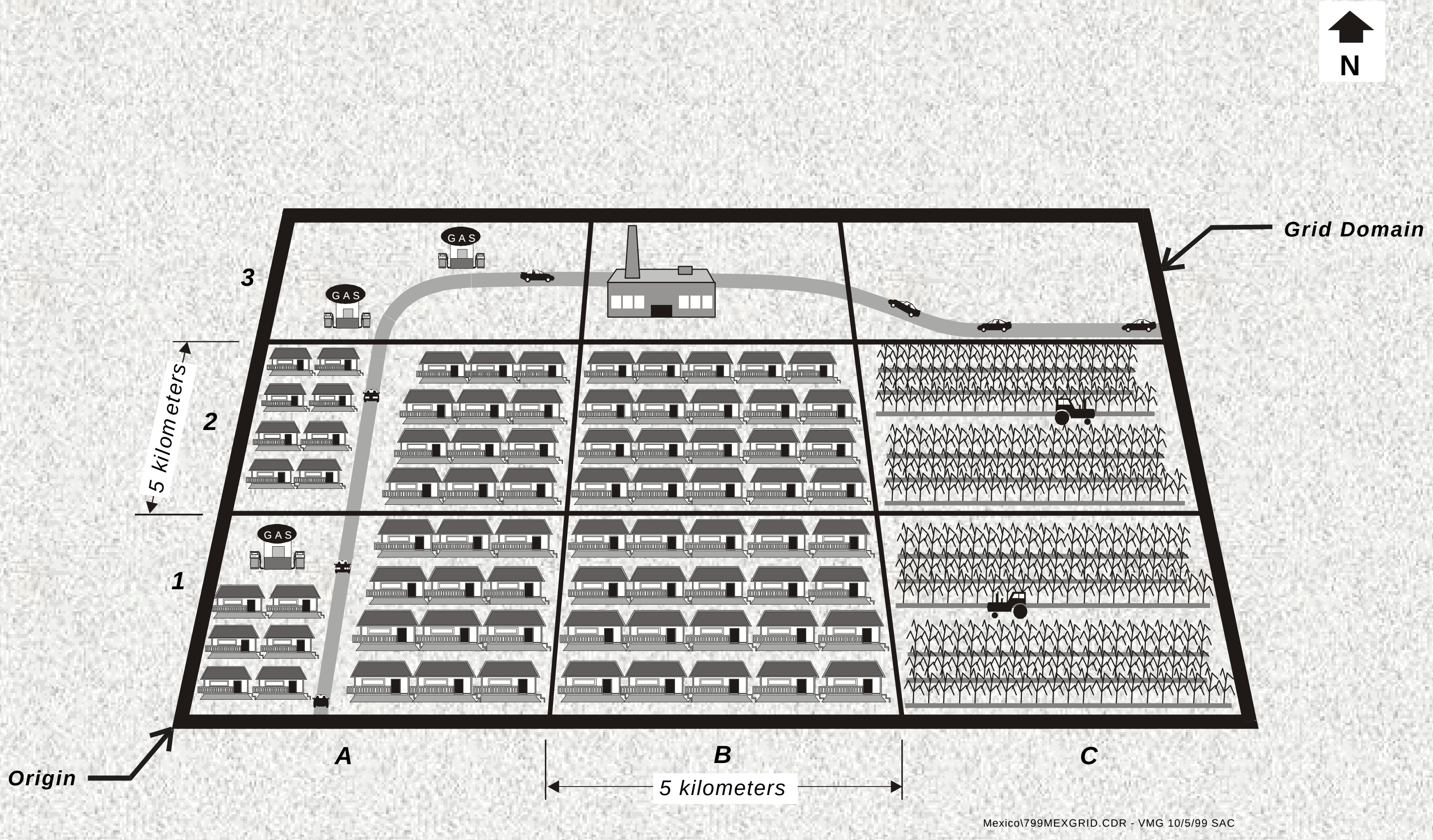
$$AF_{Cell} = AC_{Cell} / AC_{Domain}$$

AF_{Cell} = Grid Cell Activity Factor

AC_{Cell} = Grid Cell Activity

AC_{Domain} = Domain Wide Activity

Example Gridded Domain



Spatial Allocation Example (3)

- From Gridded Domain Data
  - $AF_{A,1}$ = 1 Gas Station / 3 Gas Stations
  - $AF_{A,1} = 0.333$
- Apply Gridding Factor to Annual Emissions

  $E_{A,1} = E_{Ann} * AF_{A,1}$

  $E_{A,1}$ = 150 Tons VOC/year * 0.333

  $E_{A,1}$ = 50 Tons VOC/year

Spatial Allocation Issues

- Ensure Lat/Lon Are In Proper County
  - No Sources In Lakes or Oceans
- Ensure Stacks Have Valid Data
  - No Supersonic Flow Rates
- Ensure Source and Roadway Types Are In Appropriate County
  - No Water, No Boats

Spatial Allocation Exercise

- Estimate The Annual NOx Emissions From Highway Vehicles In Grid Cell (A,3)

Spatial Allocation Exercise (2)

- From Example Spatial Ratios
  - $AF_{A,3} = 0.200$

- Apply Gridding Factor to Annual Emissions

  $E_{A,3} = E_{Ann} * AF_{A,3}$

  $E_{A,3} = 800$ Tons NOx/year * 0.200

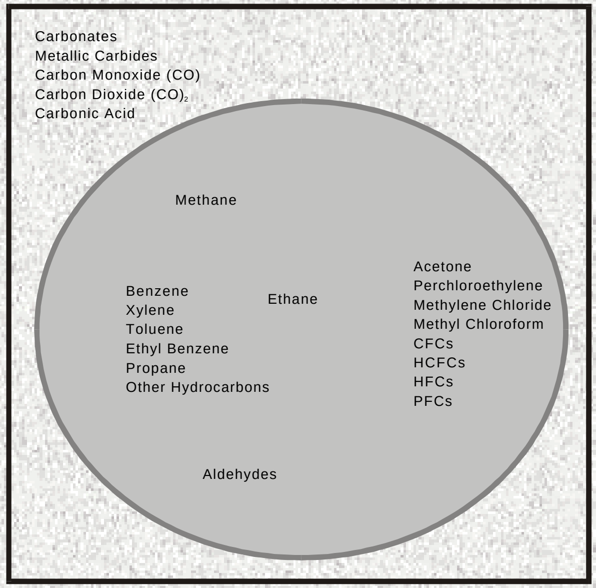
  $E_{A,3} = 160$ Tons NOx/year

Pollutant Speciation

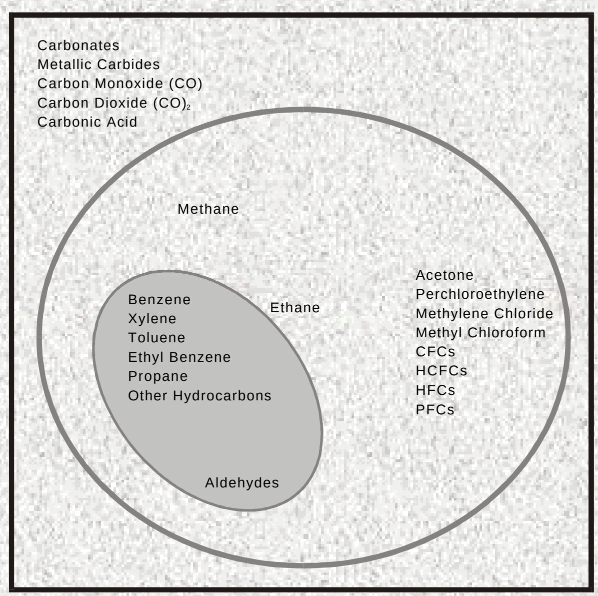
- Disaggregation of Pollutants Into Individual Chemical Species
  - Assign Speciation Profile to SCC
  - Determine Mass Fraction of Emitted Compounds
  - Determine Molecular Weight of Compound
- Used in Photochemical, Air Toxics, CMB, and Visibility Modeling

Pollutant Speciation (2)

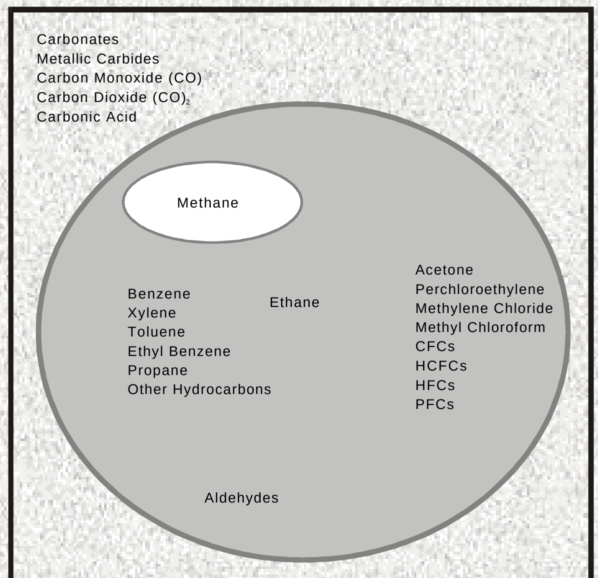
- Hydrocarbons (HC)
  - Toluene, Benzene, Ethane, etc.
- Oxides of Nitrogen (NOx)
  - NO, NO2
- Fine Particulate Matter (PM_{Fine})
  - Sulfates, Nitrates, Organic/Elemental Carbon



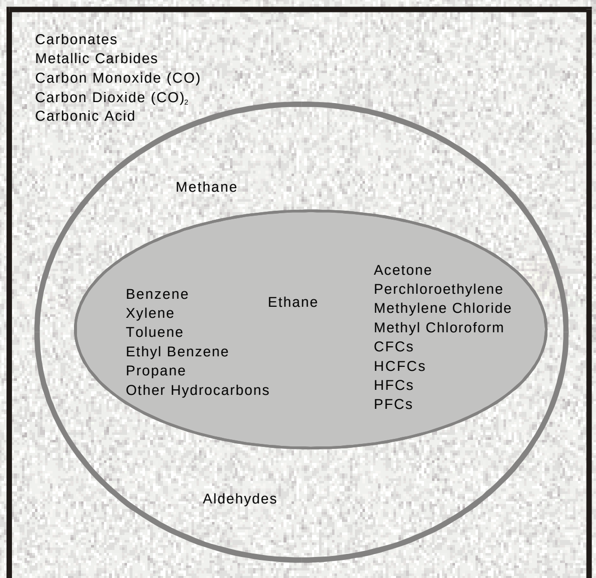
TOG/TOC



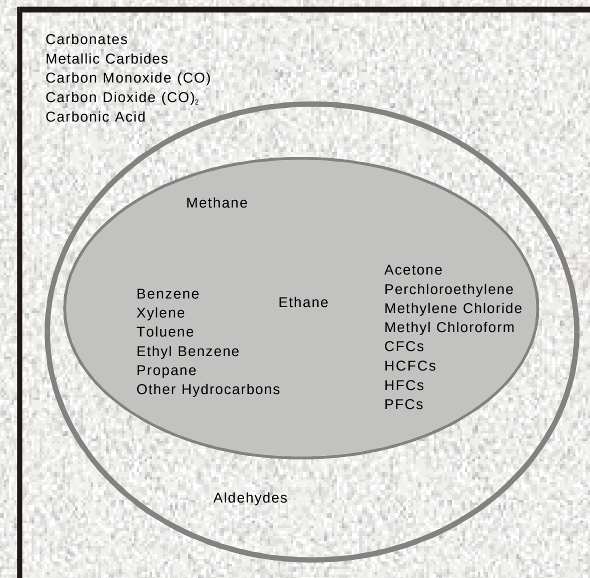
ROG/ROC/VOC



NMOG/NMOC



NMHC



THC/HC

Photochemical Modeling

- Groups Species Into Chemical Mechanisms
- Defines Reactivity and Predictions of Pollutant Transformation
  - CB-IV
  - RADM
  - SAPRC99
- Occasionally Updated/Modified With Lab Study Data

Speciation Profiles

- Used To Allocate Pollutants Based on Process Characteristics
- Ratios of Pollutant to Species
- Site Specific or Category General
- Pollutant and Process Specific

VOC Speciation Profile Example

- SCC Profile Assignment File

SCC	Profile
...	...
30101816	1004
30101817	**1004**
30101818	1004
...	...

Speciation Profile Example (2)

- VOC Speciation Profile File

Profile	**SAROAD**	**Mass Fraction**
...	...	...
1003	98090	10.0015
1004	**45203**	**0.1000**
1004	**45220**	**0.9000**
1005	45220	1.0000
...	...	...

Speciation Profile Example (3)

- Chemical Compound File

SAROAD	MW	Compund Name
...	...	...
45202	92.14	Toluene
45203	**106.17**	Ethylbenzene
45204	106.17	O-Xylene
...	...	...
45218	134.22	M-Diethylbenzene
45220	**104.15**	**Styrene**
45221	118.18	Methylstyrene
...	...	...

Speciation Profile Example (4)

- SCC 30101817: Emitting 20 Kg VOC / hour

- Mass Fraction

  $Q_{ethylbenzene}$ = 20 Kg/hr * 0.1000 = 2.0 Kg/hr

  $Q_{styrene}$ = 20 Kg/hr * 0.9000 = 18.0 Kg/hr

- Molecular Weight

  $MW_{ethylbenzene}$ = 2.0 * 1000 g/Kg * (1g-mol/ 106.17 g) = 18.838 g-mol/hr

  $MW_{styrene}$ = 18.0 * 1000 g/Kg * (1g-mol/ 104.15 g) = 172.828 g-mol/hr

Other Pollutant Speciation

- Some Generalized Assumptions
- NOx
  - 95% NO, 5% NO_2
- SOx
  - 97% SO_2

Chemical Speciation Issues

- VOC Speciated Emissions Are Not Comparable For Different Mechanisms
- Different Emission Processing Systems Are Likely To Use Different Profiles, Chemical Compound Data, and Mechanism Assignments
- Mechanism Speciation is Dependant on Chemical Compounds Identified in the VOC Speciation Profile
- Different Compound Names May Be Used by Various Mechanism Developers

Emission Projections

- Extrapolation of Baseline Estimates
  - Future Activity Level Estimates
  - Future Expected Control
- Attempt to Predict and Quantify Unknown
  - Always Some Uncertainty in Projections
  - Goal Is To Minimize the Uncertainty

Emission Projections (2)

- Uses of Projections
  - Planning
  - Evaluation of Potential Control Measures
  - New Source Impacts
  - Modeling of Future Air Quality
  - Assessment of Effectiveness of Air Pollution Control Strategies

Emission Projections (3)

- Purpose May Influence Method Selection
  - Control Cost / Grid-Based Modeling Analyses
    - Source Specific Data Requirements
  - SIP / Tracking Purposes
    - Less Detail Required
    - County/Category Aggregation Possible

General Projection Equations

- Emission Based

$$E_{fy} = E_{by} * GF * CF$$

E_{fy} = Projection Year Emissions

E_{by} = Base Year Emissions

GF = Growth Factor

CF = Control Factor

General Projection Equations (2)

- Activity Based

$$E_{fy} = A_{by} * GF * EMF_{fy}$$

E_{fy} = Projection Year Emissions

A_{by} = Base Year Activity

GF = Growth Factor

EMF_{fy} = Projection Year Emission Factor

Growth Factors

- Accounts For Changes In Activity
  - Employment, Earnings, Value Added, Output
- Important To Consider
  - Approximation of Surrogate Data to Activity
  - Relation to Base Year Activity Indicator
  - Locality Representation

Control Factors

$$CF = 1 - [RC * RE * RP]$$

CF = Control Factor

RC = Regulation Control

RE = Rule Effectiveness

RP = Rule Penetration

Control Factors (2)

- Regulation Control
  - Expected Reduction For Control Measure
- Rule Effectiveness
  - Regulatory Program Effectiveness
    - Regulation, Compliance, Performance of Regulation
- Rule Penetration
  - Quantifies Regulation’s Coverage of Category

Control Strategy Projections

- Estimates of Future Year Emissions that Include Expected Impact of Modified or Additional Control Regulations
  - Fuel Switching, Fuel Efficiency Improvements
  - Pollution Prevention Programs
  - Greenhouse Gas or Global Warming Initiatives

Emission Projection Methods

- Model Develops Projections
  - Base Year Inventory
  - Growth Factors
  - Control Factors
- Develop Projections Outside Model
  - Input Projected Inventory in Same Format as Base Year Inventory

Emission Projection Example

- Example:
  - Calculate Annual CO Emissions from Factory Boiler Assuming 25 % Growth, No Existing Control, 40 % Regulation Control, 100 % Rule Effectiveness, and 100 % Rule Penetration
- Steps:
  - Estimate Control Factor for Process
  - Apply Growth and Control To Base Emissions

Emission Projection Example (2)

- Estimate Control Factor for Process

CF = 1 - [RC * RE * RP]

CF = 1 - [(40/100) * (100/100) * (100/100)]

CF = 1 - 0.40

CF = 0.60 or 60%

Emission Projection Example (3)

- Apply Growth and Control To Base Emissions

$$E_{fy} = E_{by} * GF * CF$$

$$E_{fy} = 600 \text{ tpy CO} * 1.25 * 0.60$$

$$E_{fy} = 450 \text{ tpy CO}$$

Emission Projection Issues

- Use Local and Source-Specific Growth When Available
- Grow Emissions To Permitted Levels
- Beware of “Double Counting” Controls
- Note Multi-Pollutant Control Devices

Modeling Considerations

- Spatial
  – Accounting for Geographic Shifts in Activity
- Temporal
  – Seasonal Activity and Control
- Speciation
  – Account for Changes in Fuel or Solvent

Emission Projection Exercise

- Estimate The Annual VOC Emissions From Agricultural Pesticide Application Assuming The Following:
  - Growth Rate = 50 %
  - Regulation Control = 25 %
  - Rule Effectiveness = 100 %
  - Rule Penetration = 50 %

Emission Projection Exercise (2)

- Estimate Control Factor for Process

CF = 1 - [RC * RE * RP]

CF = 1 - [(25/100) * (100/100) * (50/100)]

CF = 1 - 0.125

CF = 0.875 or 87.5%

Emission Projection Exercise (3)

- Apply Growth and Control To Base Emissions

$E_{fy} = E_{by} * GF * CF$

E_{fy} = 100 tpy VOC * 1.50 * 0.875

E_{fy} = 131.25 tpy VOC

Specific Emissions Models

- Some Models Used To Estimate Emissions
  - Nonroad Sources
  - Highway Vehicles
  - Biogenic Emissions

- Account For Episode Specific Data
  - Temperatures, Precipitation, Cloud Cover, etc.

Nonroad Emissions Modeling

- EPA’s NONROAD Model for Most Nonroad Sources
  - Exception Airport, Commercial Marine, Railroad
- Use Local Data Where Available
- Make Sure New Nonroad SCCs are Incorporated into Emission Model
  - Spatial Surrogates
  - Temporal and Speciation Profiles

Highway Emissions Modeling

- Ozone Modeling
  - Episode Specific Hourly Emissions
  - Needed Inputs
    - Vehicle Miles Traveled
    - MOBILE Model Input Shells
    - Vehicle Speeds
- PM or Air Toxics Modeling
  - Precaclulated and Treated as Area Sources

Biogenic Emissions Modeling

- BEIS 2.3
  - Biogenic Volatile Organic Compounds
  - Soil Nitrogen Oxide Emissions
  - Episode Specific Hourly Emissions
  - Temperature and Land Coverage Dependent

Conclusion

- Modeling Inventories Are …
  - More Than Just Emissions
  - Actual Source Specific Data
    - Locations
    - Operating Data
    - Process Specifications
  - Cross-Reference Information
    - Necessary to Link to Ancillary Files
    - Fill In Missing Data!

Conclusion (2)

- “Junk In = Junk Out”
  - Extra / Alternate Steps Should be Taken to Ensure that the Inventory Can Support Temporal, Spatial, Speciation, and Projection Needs as Required by the Analysis
  - Work With Modelers to Ensure They Understand the Limitations of Your Inventory

Conclusion (3)

- Use Existing Resources
  - Websites
    - http://www.epa.gov/ttn/chief/emch/
  - Listservers
    - emregional@sol.ncsc.org
  - Workgroups
    - EIIP Emissions Modeling Workgroup
  - Other Emission Modelers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